oxygen, while but a trace of carbon dioxide had been added to it. The water in which it had been immersed had received, however, a much greater amount of carbon dioxide than could have been formed from the free oxygen taken from the water.

2. Tadpoles were placed in a jar partly filled with water, and the jar hermetically closed. After several hours, the air was analyzed, and the free gases in the water determined. These determinations showed that nine tenths of the oxygen consumed came from the air, and one tenth from the water; while, of the carbon dioxide produced during the experiment, the air contained three tenths, and the water seven tenths.

In order that the carbon dioxide given off by the tadpoles to the air might not be absorbed by the water during the experiment, a layer of olive-oil six millimetres thick was put upon the water.

3. It was found by careful and repeated observations, under perfectly natural conditions, that frogs in cold weather (so-called 'winter frogs'), in water at 0° to 15° C., remain with their heads above the surface from one-tenth to one-half the time, and while above the surface carry on from eight to twenty lung respirations per minute; showing, that, under natural conditions, the respiration of 'winter frogs' is not entirely or almost entirely carried on aquatically by the skin, as is commonly supposed (Klug and Martin).

4. The results obtained by Moreau and others, upon the respiratory function of the air-bladder of ordinary fishes, and those of Wilder, on the respiration of Amia (the mud-fish), are in general accord with the facts stated for turtles and tadpoles.

These facts seem to us to justify the conclusion that the respiratory gas-interchange in combined aerial and aquatic respiration does not conform to the law governing either exclusively aerial or exclusively aquatic respiration, but that, whenever aerial and aquatic respirations are combined in an animal, the aerial part of the respiration is principally to supply oxygen, and the aquatic part to get rid of carbon dioxide. S. H. and S. P. GAGE.

Anat. lab., Cornell univ., April 15.

Pharyngeal respiratory movements of adult amphibia under water.

In studying adult amphibia for possible respiratory movements under water, we have found that the common newt (Diemictylus viridescens) so abundant in lakes and ponds, and which is known to remain voluntarily a long time under water, carries on, while under water, rhythmical pharyngeal movements almost precisely like those of the soft-shelled turtles; and, as in the turtles, these movements cause a flow of water into and out of the mouth and pharynx.

The Cryptobranchus (Menopoma) has also been found to draw water into the mouth, and to expel it, in part at least, through the persistent gill-fissures.

So far as we know, these facts have not been published before. We would be glad to know if these observations have been previously made on Diemictylus and Cryptobranchus, and if similar pharyngeal movements under water have been described for other adult amphibia. S. H. and S. P. GAGE.

Anat. lab., Cornell univ., April 25.

The germination of pond-lily seeds.

In the issue of *Science*, March 21, 1884, there appeared a conditional offer of seeds of the Nymphea odorata, obtained by me in the fall of 1883, the growth of that year. Many of the seeds at this time were germinating; some had developed the second leaf. There was a marked difference in color; the variations were, in shades of red, from blood-red to light pink, from dark blue-green to light yellow-green, and from a dark bronze to a light salmon. It seemed to me, with varying and suitable culture, new varieties might be obtained, as the seeds are not always to be had, and the method of germination is not a matter of every-day observation. A number of applications were received, but I have not heard from any one, of successful culture, nor whether all or any of the seeds germinated. A succession of germinations gave me new plants to take the place of those destroyed by Unios, ferments, or fungi. The seed were kept under water, on sand, exposed to a north light, or that reflected from the brick houses on the north side of the street, fifty feet distant.

In June, 1855, I removed from the water all light seed, and those that were softened, as well as all on which fungoid growths had appeared, and placed the vessel in an open space where it had vertical light, and from the sun, for an hour between eleven and twelve in the morning in clear weather. A half-dozen new plants appeared in August, as the result of the change. When the cold weather came in the fall, I restored them to their old position in the north light, slightly obscured by ferns, Zygodium scandens and Pteris serrulata. About last Christmas I observed a new plant that had germinated since being brought in in the fall. This plant was removed to some submerged soil in another vessel, where it is now putting forth its fourth leaf. In February another seed germinated; and, since the 20th of March, three others have begun to grow. The last one was observed on the 3d of April. There are a few more very heavy seed in the water. The first plants from these seed that germinated early in 1884 — beginning in January — were peculiar in the length of the internodes, all being very long, some over an inch; and the seeds, before germination, were very light, and quite variable in color, but not as much so as the foliage.

The germinations of 1885 have shorter internodes, smaller leaves, of an even green color, whilst other germinations of this year have the internode reduced to a minimum; the leaves seem to start from the very dense and dark seed; and the foliage is variable in size and color, but mostly in light shades of bronze — salmon — with shades of pink.

The seeds varied in their development when taken from the pond in which they grew.

Some of the plants had just begun to coil the flower-stem by which to draw the seed down to the bottom of the pond; one had finished coiling, and the seed-vessel was in the mud; others were midway between these extremes. I mention this to show that there were natural and well-known causes for the variance in time of germination.

When it is known that the ripe and fully matured seeds are very dense, it will not seem so strange, that, considering the great number of seeds to a single flower, all ponds are not overcrowded, as by their density they sink into the ooze and remain dormant.

I shall note with interest any future germinations as lengthening the possible dormant period of these seed.

On April 19 I observed five more germinations, with the characteristics of those mentioned as growing this year. Up to April 24, three other young plants had started, making thirteen since Christmas; and these are as vigorous as those that started in 1884,— much more so than the growth of the summer of 1885. GEO. F. WATERS.

8 Beacon Street, Boston, Mass., April 24.

Eskimo building-snow.

In *Science* for April 23, 1886 (p. 372), Sergt. T. W. Sherwood has an inquiry about a certain formation of snow. I refer you to a paragraph in *Science* for April 25, 1884, p. 822, concerning 'ice-banners,' from observations of my own.

GILBERT THOMPSON.

U. S. geol. surv., April 23.

Certain homologous muscles.

The writer, having devoted some time of late to a comparative study of the myology of American mammals, has noted several interesting facts, to one of which attention is here asked.

The myology of the shoulder is, perhaps, more interesting than that of any other region, inasmuch as the variations in structure can usually be readily correlated with corresponding variations in habit. This is true in particular when applied to those changes observed in members of the same genus and family. In a forthcoming work I hope to present a mass of details illustrating the nature of these variations.

The muscular system is so plastic, and so immediate an expression of function, that it was hardly expected that many hints bearing on phylogeny could be derived from that source. Osteology, possessing as it does so many advantages in this respect, has been trusted far too exclusively, as I hope to show: at least, a careful study of the anatomy of the soft parts may be expected to furnish much confirmatory evidence. In the case of the shoulder, the omo-hyoid muscle may be said to furnish a valuable criterion by which to determine the primitive character of a species. Its presence in the archaic types, and frequent absence in specialized forms, can hardly be correlated with change in function.

The sciurimorphs are a very compact group, and yet present a great variety of modifications in adaptation to variation in habit. Among the members of the group found in the United States, the woodchuck (Arctomys monax) is perhaps entitled to rank as the most primitive form. This conception is suggested by the osseous structure, and finds an interesting support in a number of points in the myology, only two of which are here mentioned. The omo-hyoid passing from the sterno-hyoid to the anterior margin of the clavicle is very well developed. A very important part of the skin-muscle forming the covering of the cheek is derived from a broad, flat band springing from the anterior third of the sternum, the insertion being in the skin of the lips and chin. But most curious of all is the presence of a well-developed skin-muscle springing from the lower posterior free margin of the rhomboideus dorsalis, which, unlike the cucullarius, has an origin far down the back, overlapping the latissimus. The thin band of which mention is made is entirely distinct from any portion of the paniculus until it reaches the region of the cheek, where its fibres appear to lose themselves upon the skin. What gives these points interest is the fact that the only other rodent yet encountered, which has such a muscle, is Geomys, the pouched gopher. In G. bursarius an exactly similar muscle springs from the latissimus at almost the identical point, and has exactly the same course, its insertion being on the pouch, whence I have elsewhere termed it retractor bursae.

In none of the myomorphs examined has such a muscle been encountered. Without going into further detail, it will be sufficient to point out the fact that there may here be a hint of the antiquity, if not consanguinity, of these types, unless, indeed, it can be shown that an underground habit has developed in one case, — that which has its apparent explanation in the function dependent on the possession of a pouch in the other.

In the chipmunk, which is pouched, though only imperfectly fossorial and more perfectly sciurine, this muscle is absent. The spermophiles, although the nearest living American allies of Arctomys, do not possess this muscle. In the flying squirrel there is a thin band of muscle passing from the wrist, having its origin on the carpus opposite the volar spur, and passing to the same point as the muscle here described. The flying-squirrel also has a distinct omo-hyoid. C. L. HERRICK.

Dennison university, April 12.

A means of distinguishing the Canada lynx from the Bay lynx.

If a dozen zoölogists were asked how many species of lynx exist, the majority would probably decline to commit themselves to any opinion, while among the rest would be found advocates for a varying number of species, — as few as one, perhaps, or as many as eight or nine.

While examining a series of sixty or seventy skulls of American lynxes recently, I hit upon two characters which will, I believe, prove useful in distinguishing between the species more satisfactorily than has been possible hitherto. I found that in all the skulls from far north, indeed in all that were labelled 'L. canadensis,' the anterior condyloid foramen is large, looks downward, and is *not* confluent with the foramen lacerum posterium; and that the visible portion of the presphenoid is flask-shaped, the convexity being in front. In all the skulls of L. rufus, maculatus, and fasciatus, on the contrary, the two foramina are confluent, as in the cats generally, and the visible portion of the presphenoid is sagittate or linear.

The single skull of Lynx borealis in the national collection, and one of L. cervaria, exhibit the characteristics of L. canadensis.

It would appear that in the case of the American lynxes we are dealing with two distinct species only: 1°, L. canadensis; and, 2°, L. rufus, with its varieties fasciatus and maculatus. It is also probable that the confluence of the condyloid and lacerated foramina cannot hereafter be regarded as a distinguishing character of the Aeluroidea.

FREDERICK TRUE.

Washington, April 20.